Tevatron crystal collimation experiment (T-980)

by Vlasov Alexander
Moscow State University
Physical faculty
Departments of physics of elementary particles

Mentor: Dean Still

Fermilab

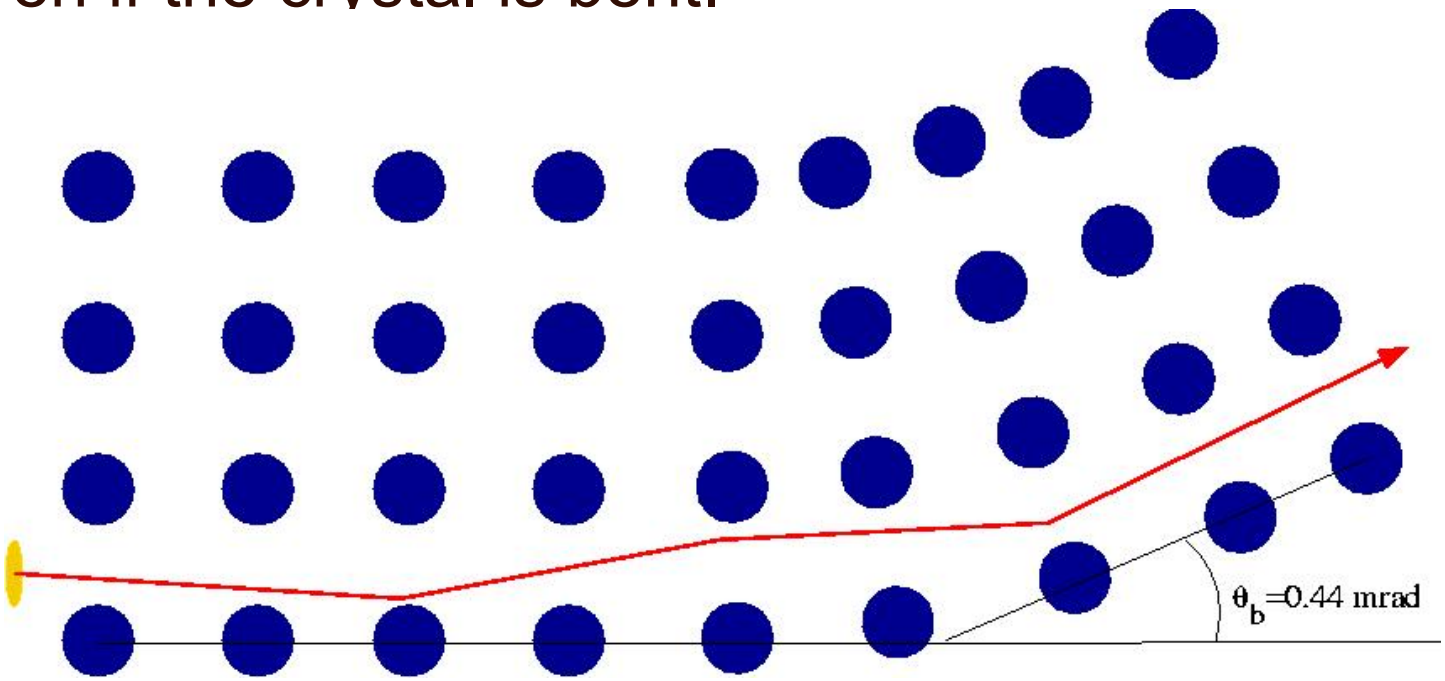
Tevatron crystal collimation experiment

New approach to remove beam halo, reducing heat load on cold magnets. Proposed to be used in next LHC collimator upgrade (approximately 2015). Main advantage – can remove beam halo in 1 pass with higher efficiency.

Fermilab

Crystal channeling

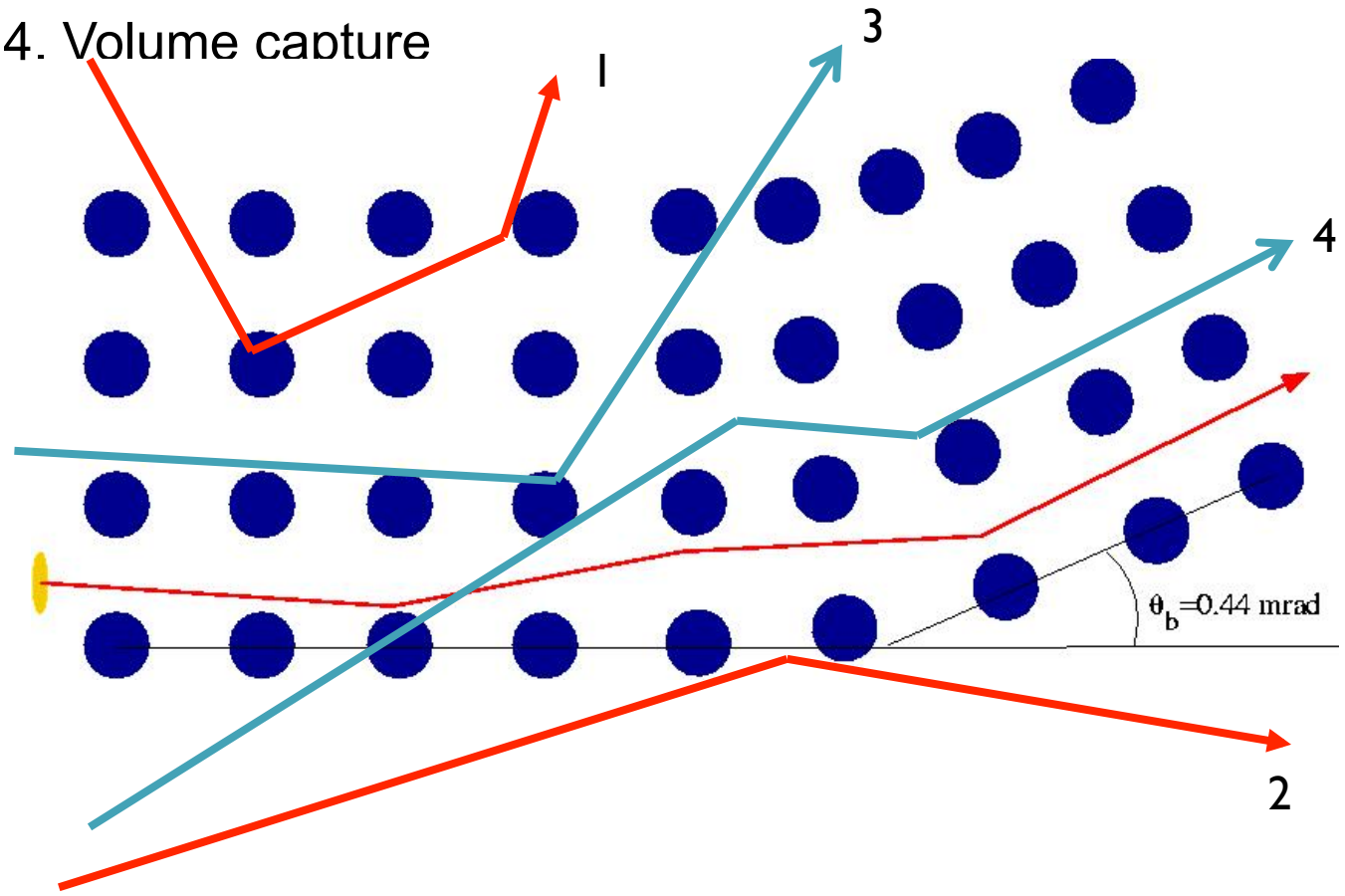
If particles entering a crystal are properly aligned to the crystal planes, they will follow the planes, even if the crystal is bent.



Fermilab

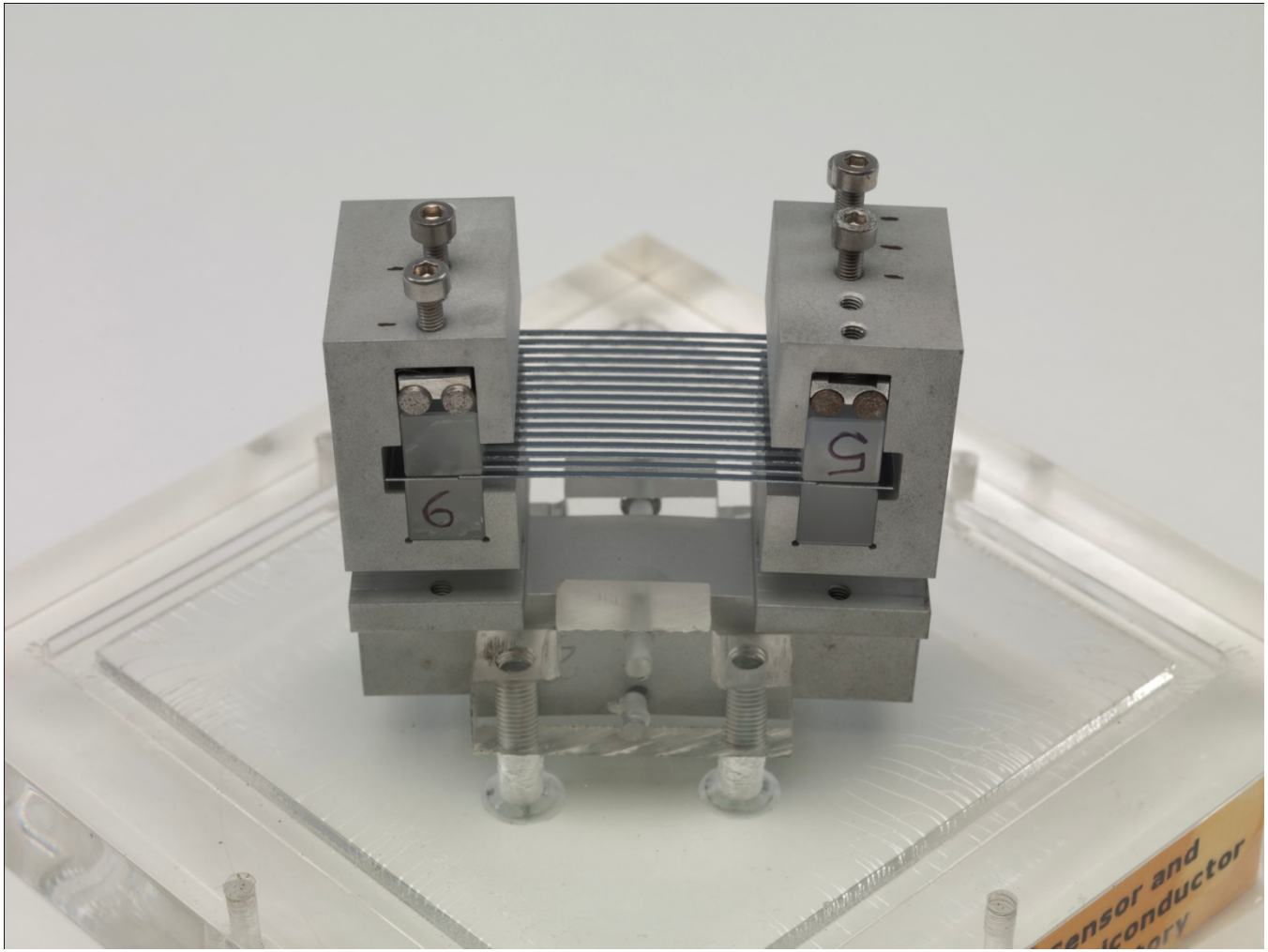
Other processes in a bent crystal

- 1. Amorphous orientation
- 2. Volume reflection
- 3. De-channeling
- 4. Volume capture



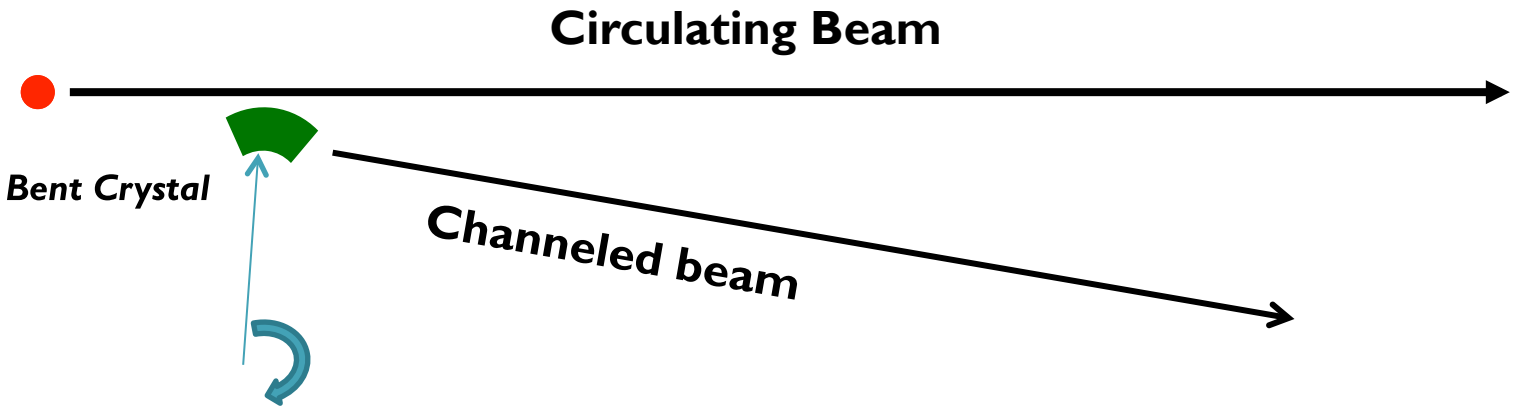
Example of a crystal

Multi-strip silicon crystal (16 strips)



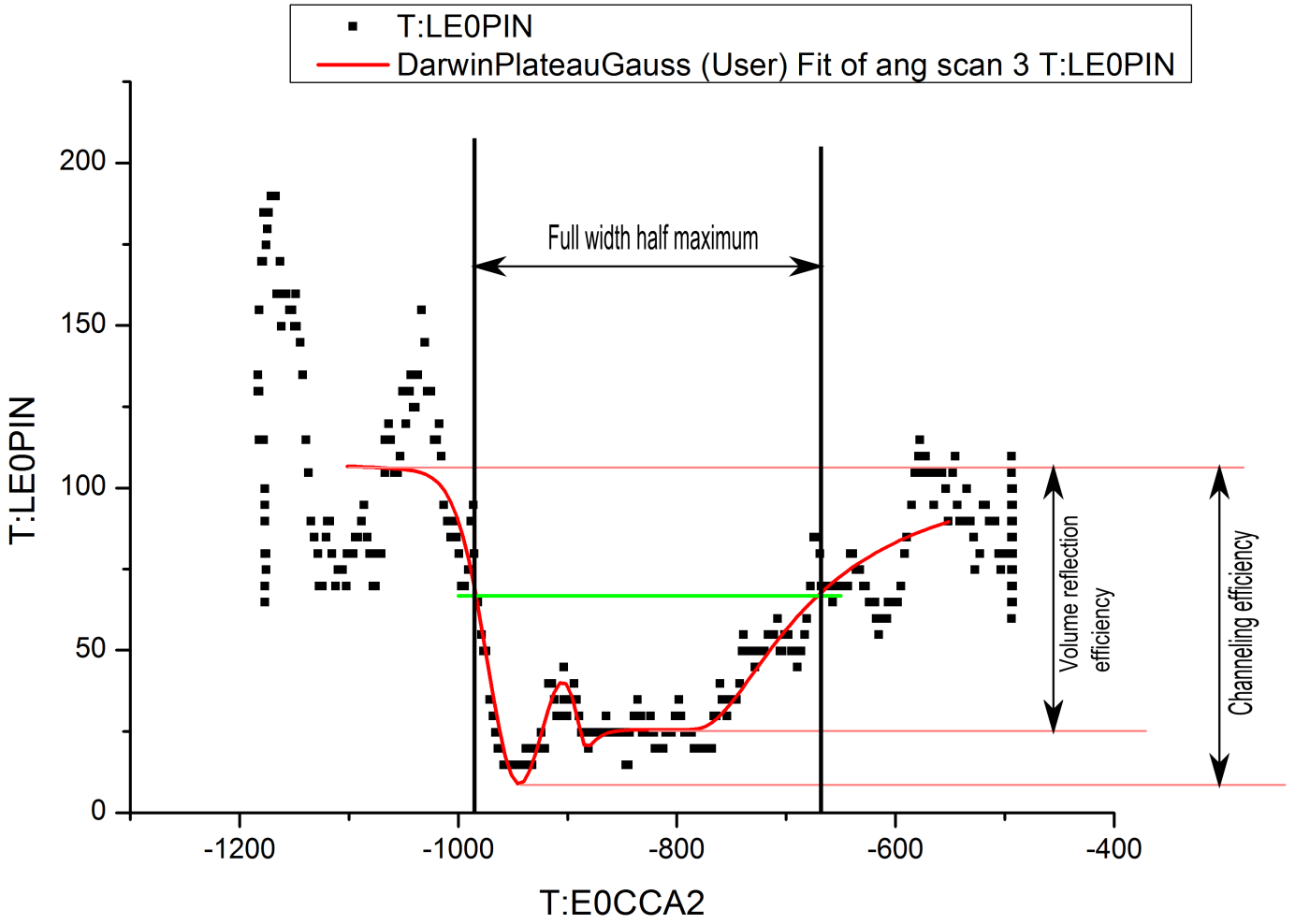
System setup – angle scan

Angle of crystal in respect to the beam is changed.
Crystal goes to "channel" or "volume reflection" mode.



Fermilab

Angle scan data and results



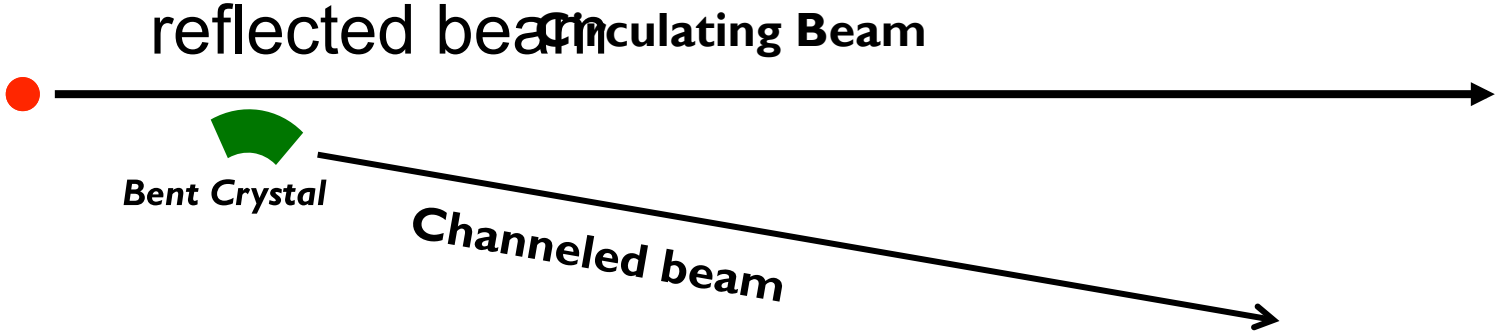
Fitting the data

- Function for fitting: combination of Darwin plateau and a Gaussian.
- Parameter of a “width” is determined as full width on a half of volume reflection efficiency.
- Also “sigma” parameter for Gaussian and width of plateau are listed.
- Efficiency calculated in percents. 100% corresponds to from zero to y0 level.

Fermilab

System setup - collimator scans

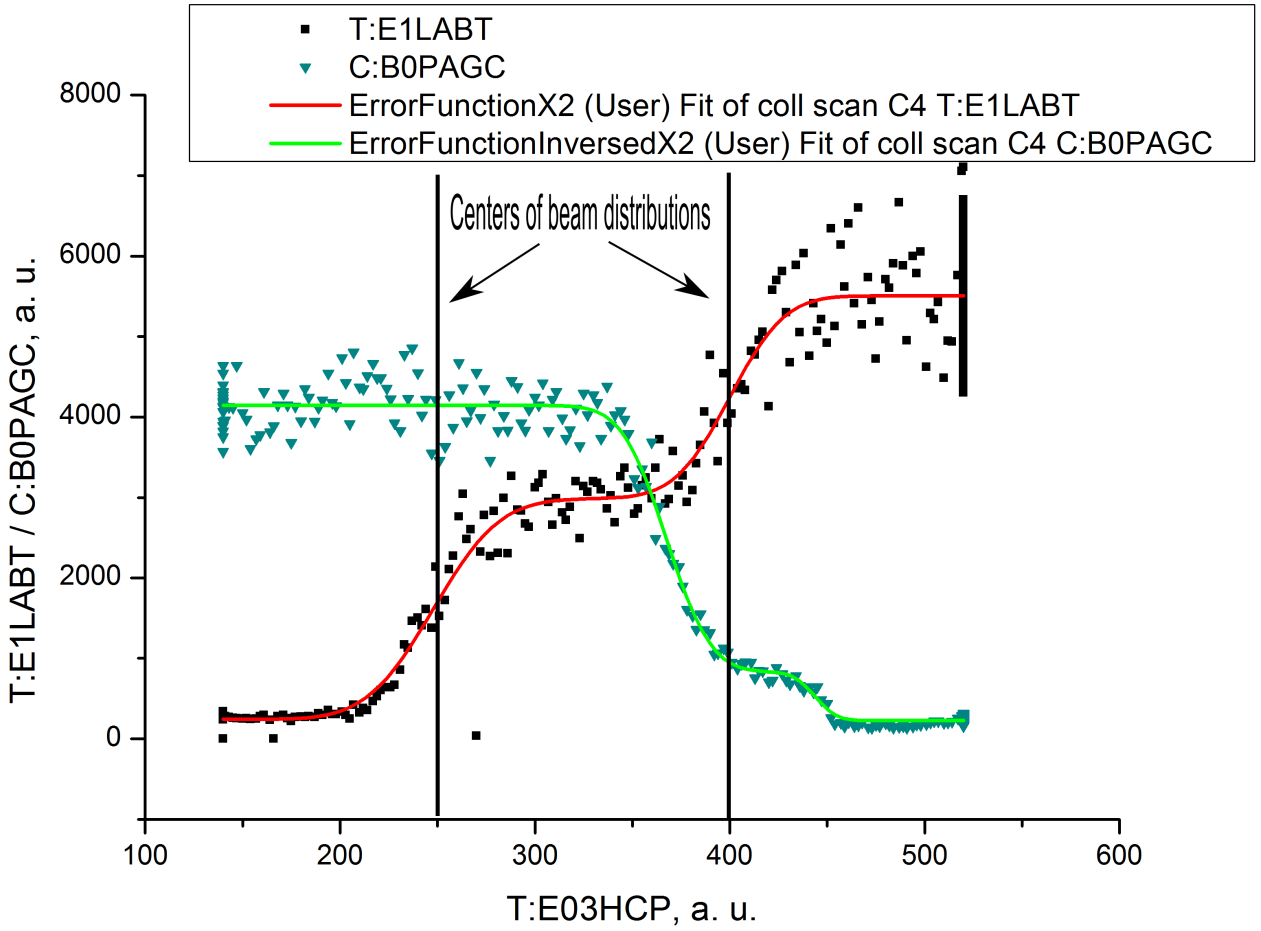
- Collimator is moved to find a distribution of channeled or reflected beam and a displacement between main and channeled/ reflected beam



Collimator

Fermilab

Collimator scan data and results



Fitting the data

- Depending of a beam profile, different number of Error functions was used.
- Fitting gives a displacement between channeled/reflected beam and the main beam, so gives a channeling/reflection angle, connected with crystal bend angle.
- It looks like there are aperture effects between E1 and B0.

Fermilab

Results

The data from 2005 till 2010 is analyzed: angle scans and collimator scans.

Simulation data was analyzed and showed right choice of fitting functions.

Gaussian profile of channeling efficiency vs. angle confirmed.

Numerical data for 3 crystals and plots are linked to T-980 collaboration website.

Fermilab

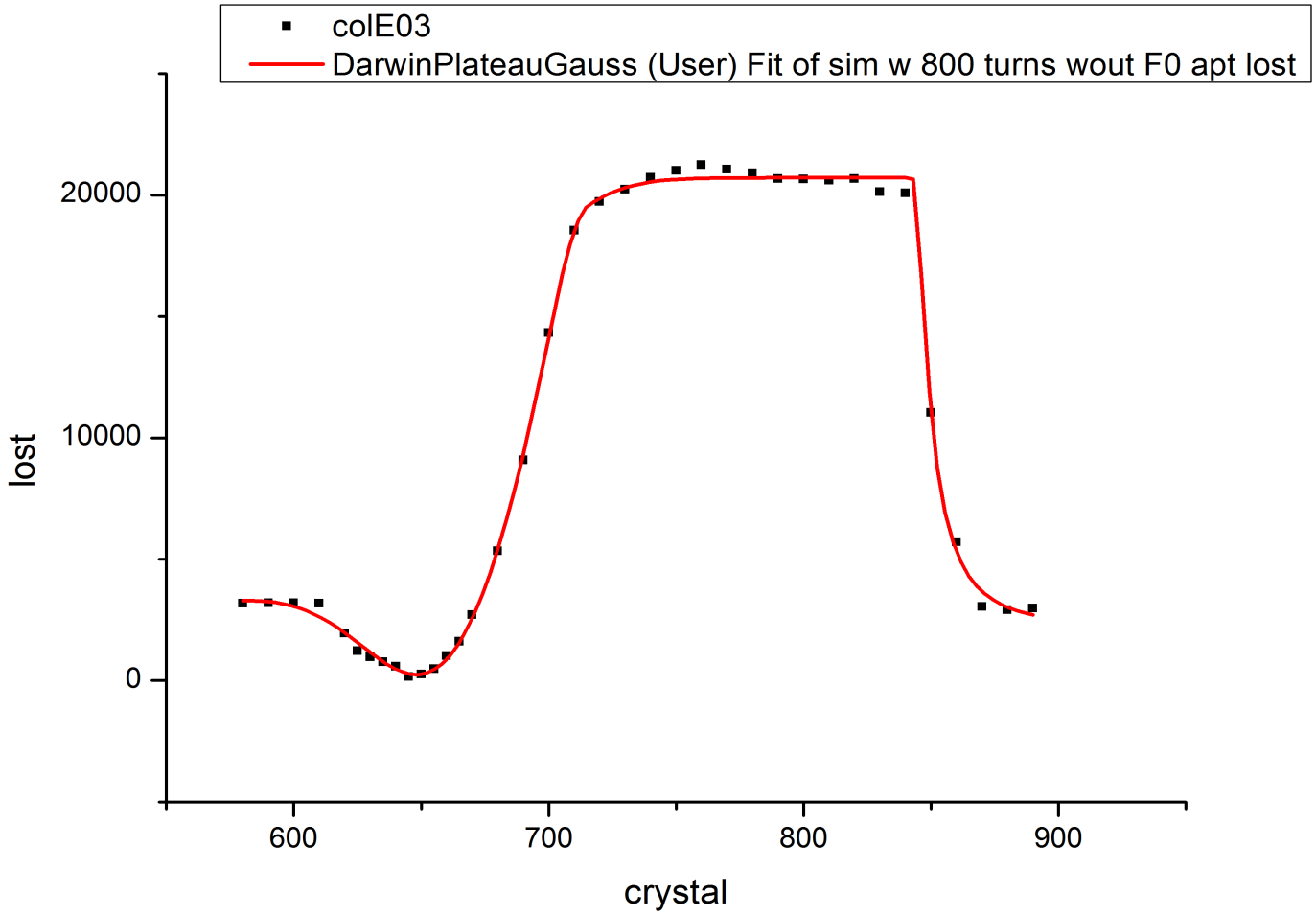
Experimental results

Parameters	Crystal		
	O-05-09	MS-08-09	O-BNL-02
Channeling peak position, experimental, urad	-961 (+/- 9 (stat) +/- 2 (instr))	655 (+/- 10 (stat) +/- 3 (instr))	-
Channeling peak position, simulation, urad	-963 (+/- 2 (stat) +/- 1 (instr))	658.5 (+/- 2.1 (stat) +/- 1.3 (instr))	-
Channeling width, experimental, urad	16 (+/- 5 (stat) +/- 2 (instr))	59 (+/- 12 (stat) +/- 3 (instr))	-
Channeling width, simulation, urad	10.5 (+/- 1.2 (stat) +/- 1.1 (instr))	26 (+/- 2 (stat) +/- 1 (instr))	-
Full bend angle, experimental, urad	280 (+/- 54 (stat) +/- 100 (instr))	255 (+/- 29 (stat) +/- 6 (instr))	444 (+/- 22 (stat) +/- 108 (instr))
Full bend angle, expected, urad	360	200	410 (+/- 20)

Thank you for attention

Extra slides

Simulation data



R-squared 0.999

Fermilab